Information

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Inhalation Therapy

Joint Accord on the Role of Respiratory (Inhalation) Therapy Personnel in Airway Management and Endotracheal Intubation endorsed by the California Medical Association, the California Hospital Association, the California Society for Respiratory Therapy, the California Society of Anesthesiologists and the California Thoracic Society

THE FIRST STEP in resuscitation from cardiac arrest, respiratory failure or acute airway obstruction is the establishment of a patent airway. This usually involves positioning of the patient and the use of an artificial airway inserted through the mouth or nose into the pharynx or trachea. Removal by suctioning of inhaled or obstructing secretions or vomitus is frequently necessary.

In the hospital situation teams of health personnel, i.e., nurses and respiratory therapy personnel approved by the hospital medical staff, are trained to respond to emergencies and take responsible action in the absence of a physician. If a suitably trained physician is present, he will take charge of the emergency situation. In his absence we recognize the propriety of having specially trained and authorized personnel perform the necessary steps involved in respiratory resuscitation if the following requirements have been satisfied:

1. A procedure is established and adopted by the medical staff of the hospital.

2. A suitable training program in resuscitation and emergency airway maintenance is established and conducted by a physician or physicians appointed by the medical staff for members of the resuscitation team.

3. Personnel who satisfactorily complete the training program and demonstrate competence shall be certified by written documentation. Such documentation will be kept in their personnel files.

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Water Disinfection in the Wilderness

A Simple, Effective Method of Iodination

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BEFORE WORLD WAR II, when backpacking and foreign travel were less common, the traveler gave little or no thought to water contamination. It was assumed that mountain streams were pure. With improved surveillance it is known that most streams of the United States are polluted.[1] Waterborne disease continues to be important in undeveloped areas, here and abroad,[2-4] though in urban areas of the United States it is uncommon. Reliable data on the incidence of waterborne disease among travelers are not available, yet potentially waterborne diseases including Salmonella infections, amebic dysentery, giardiasis and infectious hepatitis are commonly observed among travelers returning from abroad and from remote areas of the United States.

The authors' interest in water disinfection was sharpened when they acquired giardiasis after drinking from a partly frozen stream on the Long Valley trail to Mount San Jacinto, California. At this time in early May 1971, human habitation of the area was sparse, and snow covered the ground. Cold weather is no protection from intestinal parasitism, and may present a problem in water purification, as will be explained later.

A water disinfectant must be able to kill the hardiest of each group of organisms, especially amebic cysts, which are hardier than their active forms, and enteroviruses, the most resistant to

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disinfection of the pathogenic microorganisms. At the same time, the toxicity of the chemical must be very low compared with its germicidal potency. A water disinfectant for the traveler presents special requirements which are of less importance to the municipal water sanitary engineer. These include simplicity, effectiveness in the presence of nitrogenous pollutants, rapidity of antimicrobial action over a wide pH range and immediate palatability. The backpacker will, of course, demand light weight.

Iodination meets these requirements,[5-7] and offers a number of advantages over the time-honored chlorination[8,9] of small quantities of water with p-dichlorosulfamoyl benzoic acid (Halazone®).

During World War II, Halazone was issued for individual use when other forms of water treatment were not available. Though Halazone produced potable water in the absence of heavy contamination, its efficacy in treating cold, heavily polluted water containing resistant forms such as viruses and amebic cysts was seriously questioned. In 1942, at the request of the armed forces, investigators at Harvard University initiated a search for a more dependable technique of water sterilization. This study recommended the use of iodine for treatment of small quantities of water. A technique for iodination was developed and adapted by the armed forces.[10] Subsequent investigations confirm the superiority of iodination as a personal water germicide, yet Halazone continues to be widely used and is currently the only commercially available agent for this purpose in Southern California.

Chlorination

Chlorination by Halazone in the recommended dose depends on the slow release of 2.8 parts per million (ppm) of free chlorine for its immediate antimicrobial action.[11] Chlorine under ideal conditions, namely a pH of 7 or lower and the absence of nitrogenous compounds, hydrolyzes to hypochlorous acid ($HClO$). The highly active $HClO$ is an excellent germicide.[12,13] The high reactivity of $HClO$ is its main defect as a personal water disinfectant, since in the presence of amino and ammonia ions $HClO$ is quickly converted to relatively inactive monochloramine.[14] Above pH 7 $HClO$ hydrolyzes to the less active hypochlorite.

These two problems are solved in water purification plants by the practice of breakpoint chlorination. Breakpoint chlorination is the application of sufficient chlorine to bind with the organic materials in the water, while leaving a biocidal residual of free chlorine. But this technique requires continual testing and is not practical for rapid treatment of small quantities of water. The individual traveler must resort to simple chlorination, the practice of adding a fixed dose of a chlorine compound to water of uncertain quality. Simple chlorination is unpredictable,[15] and may be useless against bacteria[16] and enteroviruses[9,17] when water is contaminated with organic material.

A number of waterborne disease outbreaks have occurred when simple chlorination was practiced.[18] Neefe's classic study of an infectious hepatitis epidemic demonstrated the failure of combined chlorine to inactivate the hepatitis virus.[19] Enteroviruses were recovered from chlorinated tap water in Paris when breakpoint chlorination was not practiced.[20]

Additional disadvantages of Halazone are slow solubility and a short shelf life of five months when stored at 32°C (89.6°F). Potency is reduced 50 percent when stored at 40° to 50°C (104° to 122°F),[21] the temperature range one might expect in an automobile glove compartment on a summer day. Halazone loses 75 percent of its activity when exposed to air for two days.[22]

Iodination

Iodination, in contrast, with a weak aqueous solution of 3 to 5 ppm of elemental iodine (I_2) will destroy amebae and their cysts, bacteria and their spores, algae and enteroviruses at 25°C (77°F)[4] in 15 minutes or less (see Chart 1).[4,7,8] At near freezing (3°C, 37.4°F) disinfection will require 20 to 30 minutes at the same concentration of iodine, since germicidal potency is roughly proportional to temperature. Elemental iodine does not react readily with ammonia and amino ions, and therefore will remain an effective disinfectant in water polluted with nitrogenous wastes.[7,8] Iodine is effective over a wide pH range, hydrolyzing at pH above 6 to hydroiodous acid, which is a faster virucide than I_2.[8]

Iodination can be accomplished in three ways. One method is the addition of eight drops of 2 percent tincture of iodine to a quart of water, but this results in water of less than acceptable palatability.[22] A second is the addition of a tablet of Globaline® (tetraglycine hydroperiodide) to a quart of water, releasing active iodine in a concentration of 8 ppm. Globaline tablets lose 20 percent of their effectiveness when stored in sealed bottles at 75°C (167°F) for 24 weeks. They lose 33 percent of their initial activity when exposed to air for four days.[22] The third method, described below, using crystals of elemental iodine, has been recommended for treatment of water supplies of villages in underdeveloped countries,[8] but has not been previously described for use as a personal water germicide.

Procedure for Iodination Using Crystalline Iodine

The only equipment needed for iodination with crystalline iodine is a one ounce clear glass bottle, with a leak-proof bakelite cap, containing 4 to 8 grams (or any small quantity) of USP grade resublimed iodine (I_2). The bottle is filled with water and capped, shaken vigorously for 30 to 60 seconds, then held upright for a few moments to permit the heavy iodine crystals (specific gravity 4.6) to fall to the bottom. The iodine crystals are not to be used directly. Disinfection is accomplished at 25°C (77°F) by the addition of 12½ cubic centimeters (cc) of the near saturated supernatant iodine solution to one liter of water, to achieve a final concentration of 4 ppm iodine. Since the concentration of the saturated iodine solution varies with its temperature (see Table 1), only 10 cc of iodine solution would be needed if the bottle were kept at body temperature. At near freezing, 20 cc of iodine solution would be used per liter. (The cap of the iodine bottle may serve as a measuring device.) After a contact time of 15 minutes, the water is disinfected. When more disinfected water is desired, the above steps are repeated almost 1,000 times without replenishing the iodine crystals. The shelf life of crystalline iodine is unlimited. Under usual circumstances, a 2 ppm iodine solution with a contact time of 40 minutes would offer improved palatability and effective disinfection.

If increased germicidal potency is necessary because the water is turbid, cold or known to be heavily contaminated, the concentration of the iodine solutions could be increased to 8 ppm, with a contact time of 20 minutes.[5] However, in the interest of palatability, one may prefer not to increase the concentration, but instead increase the contact time (see Chart 1).

A clear glass bottle is recommended for the above procedure to permit observation of the iodine crystals. Plastic bottles of all types take on an opaque brown stain after long exposure to the working solution. Further, plastic bottles tend to leak as one travels to high altitude, and distort and crack on descent to low altitude.

By all measures, the toxicity of iodine is remarkably low in the concentrations used for water disinfection.[9,23-25] Only persons with a specific sensitivity to iodine, and perhaps those who have been treated for hyperthyroidism risk any ill effects. The only danger of the above procedure is the inadvertent ingestion of iodine crystals, although an ounce of iodine solution would be harmless. No fatality from ingestion of less than 15 grams of iodine has been reported.

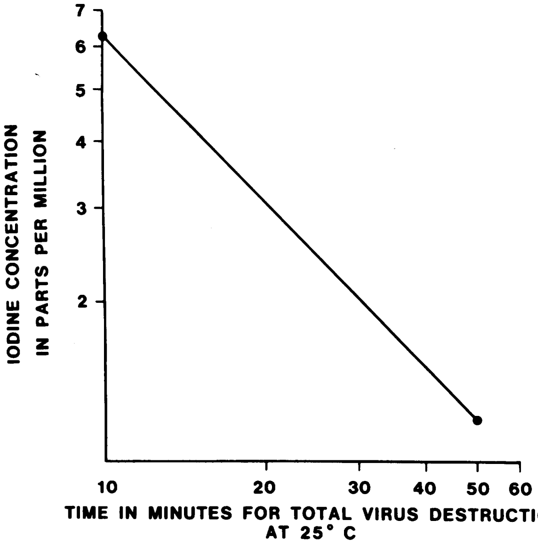

Chart 1.—The relationship of iodine concentration to contact time for the inactivation of enterovirus (Coxsackie B_1), taken from Chang.[5] This enterovirus has a high resistance to disinfection, estimated to be comparable to that of the infectious hepatitis virus.[8]

Conclusion

The use of iodine releasing tablets for emergency water disinfection has been employed by the United States Army since World War II, replacing chlorination with Halazone tablets. Chlorine,

TABLE 1.—*The Volume at Various Temperatures of a Near Saturated Solution of Iodine Added to One Liter of Water to Yield an Iodine Concentration of Four Parts per Million*

Temperature	*Volume*	*ppm*	*Capfuls**
3°C (37°F)	20.0 cc	200	8
20°C (68°F)	13.0 cc	300	5+
25°C (77°F)	12.5 cc	320	5
40°C (104°F)	10.0 cc	400	4

*Assuming a capful of standard 1 ounce glass bottle is 2½ cc.

except when breakpoint chlorination is practiced, is not a reliable disinfectant. This is so because the hydrolysis products of chlorine are less active at pH over 7 and in the presence of amino and ammonia ions. Iodination rapidly inactivates the known human pathogens, including the enteroviruses which are the most resistant to disinfection. Iodination is effective over a wide pH range, and in the presence of nitrogenous pollutants. A simple, lightweight iodination method using iodine crystals with unlimited shelf life is described for use by travelers and backpackers.

For a more detailed and technical discussion of water disinfection the reader is referred to the papers from the Sanitary Engineering Center, United States Public Health Service, Cincinnati, Ohio,[5,8,9,18] and the most current review of water disinfectants.[26]

Summary

There is a need among travelers and hikers for an effective, palatable water disinfectant with rapid action and long shelf life. A method of iodine disinfection which meets these requirements is described. A one ounce glass bottle containing 4 to 8 grams of iodine crystals is filled with water, then shaken vigorously to produce a near saturated solution of iodine. At 25°C (77°F), 12.5 cubic centimeters of this supernatant solution is added to one liter of water to be disinfected. In less than 15 minutes pathogenic bacteria, amebic cysts and viruses will be inactivated. This procedure can be repeated almost 1,000 times without replenishing the iodine crystals.

This method is compared with Halazone disinfection and other iodination methods, some of which are not currently available.

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